



**US Army Corps  
of Engineers®**

Engineer Research and  
Development Center

**Ongoing Research**

## **Phosphoric Acid Fuel Cell (PAFC) Demonstration Program**

### **Description**

Fuel cells produce electricity, heat, and water through an electrochemical process. PAFC power plants are far more fuel-efficient, and produce much less noise and air pollution than traditional power generation methods. In fiscal years 1993 and 1994, the U.S. Congress funded the use of PAFCs at Department of Defense (DOD) installations. The Construction Engineering Research Laboratory (CERL) was assigned the mission of managing the Fuel Cell Demonstration Program for the DOD. From 1994 to 1997, the PAFC Demonstration Program installed PAFCs at 30 U.S. DOD bases. The program's objectives were to:

- demonstrate fuel cell capabilities in real world situations
- stimulate growth and economies of scale in the fuel cell industry
- determine the role of fuel cells in DOD's long-term energy strategy.

### **Problem**

Traditional methods of electrical generation are inherently inefficient. They burn fuel and air to generate a high-temperature gas, which, in turn, is expanded in a mechanical device (e.g., a cylinder or turbine) to ultimately drive an electrical generator. A coal-burning power plant, for example, transfers heat from this hot gas to boil high pressure water. Gasoline, diesel, or gas-turbine engines use the hot combustion gas itself at high pressure.

A fuel cell uses these same basic chemical reactions, but generates electricity directly as an electrochemical device. This direct conversion of chemical to electrical energy is more efficient and generates much less pollution than do traditional combustion methods. Quite simply, fuel cells can generate more electricity than traditional methods—from the same amount of fuel.

### **Products**

In this project, CERL collaborated with industry partners to develop turnkey PAFC packages for application at DOD sites. This involved devising site criteria, screening DOD candidate installation sites against selection criteria, evaluating viable applications at each candidate site, coordinating fuel cell site designs, managing installation and acceptance of the PAFC power plants, and following up with regular performance monitoring and reporting.



**Fuel cell installation at Fort Huachuca, AZ.**

### **Users**

As of November 1997, this program installed PAFC power plants at 30 DOD installations. All fuel cells installed in this project are being monitored to determine overall system reliability. Results will be used to determine the role fuel cells should play in DOD long-term energy supply strategy.

This project worked to match the PAFC technology to user needs and power configurations. Interfacing the PAFC power plant with an installation energy configuration is a function of compatibility with both the electrical and thermal loads at individual buildings. Potential applications at DOD sites include central heating plants, hospitals, dormitories/barracks, gymnasiums/pools, office buildings, laundries, and kitchens. PAFC power plant thermal output can be used to preheat boiler make-up water for heating swimming pools, and for DHW used for showers, laundry, and kitchen loads. With an optional high-grade heat exchanger, high-temperature thermal output can be used for boiler plant aerators, space heating loops, absorption chillers, and industrial processes.

### **Benefits**

The 200 kW PAFC power plants (with an assumed availability of 90% or greater) being installed in this demonstration can displace more than 1.5 million kilowatt hours per year of purchased electricity at each site. Use of the thermal energy byproduct (approximately 900,000 BTUs/hr) of the fuel cell may be used to displace combustion-based, less environmentally friendly production of thermal energy. Overall annual energy savings will vary depending on local utility rates. Estimated net energy savings for each of the sites varied from \$16,000 to \$103,000 per year. These energy savings do not include additional environmental cost benefits of using a non-polluting energy source.

Fuel cells can be configured to meet special needs:

- To provide back-up power. PAFC power plants have been used to back-up critical computer loads, acting as an uninterruptible power source (UPS).
- To provide premium power to facilities where “clean” power is required for sensitive electronic equipment.
- To provide power generation facilities in noise restricted areas. Fuel cell noise emissions are quite low compared to traditional combustion technologies. At 30 ft, the noise specification level for the PC25C power plant is 62 dBA.
- To provide “ready-made” power generation to isolated sites. Packaged PAFC power plants are self-contained units with interface outlets ready to be connected to building loads.
- To provide power generation facilities in areas requiring low-emissions equipment, e.g., in congested urban areas.

### **ERDC POCs**

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